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Published in:
MOJ Addiction Medicine and Therapy

Published: 15/02/2019

Document Version
Publisher's PDF, also known as Version of record

Research Article
Open Access

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Abstract

It is common to gain weight when stopping smoking and although some products have been found somewhat effective at helping to prevent weight gain, research into the use of electronic cigarettes and weight change during smoking cessation is currently limited. Using a mixed design, 66 participants were recruited through a stop smoking service during their smoking cessation attempt with 21 participants receiving nicotine replacement therapy, 22 using electronic cigarettes and 23 using Champix as a smoking cessation aid. Participants self-completed a series of psychometric tools measuring height, weight, waist circumference, nicotine dependency, eating behaviour and physical activity. Data were collected at baseline, 4 weeks, 12 weeks and at 6 months. Findings revealed that weight, waist circumference and BMI increased regardless of the smoking cessation aid used over the 6-month cessation period. No significant effects of ethnicity on weight change during smoking cessation were found. The biggest predictor of weight change was sex, with women more likely to gain weight during smoking cessation. This is thought to be due to susceptibility to emotional eating and changes in eating behaviours. Further research should consider tapping into emotional eating and changes in eating behaviour among women who are attempting to give up smoking.

Keywords: weight change, smoking cessation, electronic cigarette, cessation aid, gender

Volume 6 Issue 1 - 2019

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Received: January 10, 2019 | **Published:** February 15, 2019

Introduction

Weight gain can be a barrier to giving up smoking. There is a body of literature on the relationship between smoking cessation and weight gain that has compared different smoking cessation aids and their effect on weight change.[1–5] There are a variety of products available to assist withdrawal symptoms,[4,6–10] the most common being Nicotine Replacement Therapy (NRT) and Varencline Tartrate (Champix). NRT is the use of alternative (gum, patches) nicotine-based products and Champix is a drug that blocks nicotine receptors. However, electronic cigarettes (e-cigarettes) are now becoming an increasingly more popular type of smoking cessation aid [11,12] estimated 2.6 million adults in Great Britain are now using e-cigarettes. E-cigarettes are an electronic device that creates a vapour that delivers nicotine. E-cigarettes have been reported as successful at helping people to stop smoking and remain smoke-free, with minimal side effects.[13,14] E-cigarettes are commonly used by both men and women, however women are more likely to use them to manage weight.[15] It has also been found that conventional and e-cigarettes have different effects on body weight and food intake,[16] which implies that e-cigarettes can have an effect on weight during smoking cessation, though research in this area is currently limited.

Furthermore, weight gain is strongly associated with increased risk of common diseases like diabetes and heart disease. South Asian populations are twice as likely to develop Diabetes, than other ethnic groups in the UK; and at an earlier age; and Coronary Heart Disease (CHD) is more prevalent among the South Asian population.[17] Smoking is also very common in South Asian men,[18] highlighting the importance of examining smoking cessation issues within this population.[19] Moreover, South Asian groups in the UK have been found to show low levels of motivation in stop smoking attempts,[20] which could signify a need for developing culture specific interventions within ethnic minorities to increase motivation and prevent relapse.[20]

Previous research examining weight gain during smoking cessation among Asian populations remains limited. Fulkerson & French,[21] found that, for women, all ethnic groups were equally likely to smoke to prevent weight gain and Asian men were more likely to smoke to prevent weight gain than were white men. Tsai et al.[22] found similar results in that Asian women were more likely to continue smoking to control their weight.[23]

Investigating weight change and smoking cessation within different ethnic populations is important as weight gain can often be a reason why people choose not to quit.[15,21,24–27] By looking at the use of e-cigarettes when quitting smoking, it is possible to identify whether they are more successful at preventing weight gain than other smoking cessation aids (NRT, Champix). It is common to gain weight when stopping smoking and although some products have been found to be somewhat effective at preventing weight gain,[9,10] evidence is limited for e-cigarettes.[15]

It is important to also consider other variables that may affect weight gain during smoking cessation, such as eating habits and physical activity levels because it is common for people making one lifestyle change (stop smoking) to combine this with another healthy behaviour,[28] which can impact on weight (e.g. exercise). The aims of the study were therefore threefold. Firstly, to determine whether weight change occurs when giving up smoking with a smoking cessation aid (NRT, Champix and e-cigarette). Secondly, to investigate whether e-cigarettes help to prevent weight gain during smoking cessation. Finally, to examine whether Asian populations (Pakistani, Bangladeshi, Indian and Chinese) are more likely to gain weight during a quit attempt than other ethnic groups. It was hypothesised that there would be less weight change when using e-cigarettes compared with other cessation aids. It was also predicted that there would be a difference in weight change between ethnic groups.

Method

Participants

UK Borough Council permission was granted to recruit participants via a local stop smoking service. Over 30% of the population in the targeted region are Asian. Participants had already discussed and decided their choice of product with a specialist advisor prior to study taking place. A power analysis using Gpower (Faul & Erdfelder, 1996) was carried out to determine the appropriate sample size that would enable any effects to be identified. A minimum effect of 0.25 and a power of 0.95 was decided and the power analysis revealed that a sample size of 66 or more would be large enough to detect such effects. See Table 1 for participant details within each smoking cessation aid group.

Materials

An information sheet was used to brief participants about the study details and ethical safeguards. A consent form was provided for signing and a debrief sheet was distributed after participation. A self-designed instrument was created to measure demographic variables not captured elsewhere; including details of participant background, smoking history and previous smoking cessation attempts. Questions also determined: age; ethnicity; sex; previous quit attempts and smoking history; weight; BMI; exercise; diet and lifestyle history (including number of alcohol units consumed per week). A series of five previously validated and reliable questionnaires were employed:

Eating behaviour

The Adult Eating Behaviour Questionnaire (AEBQ),[29] measured eight different aspects of eating behaviour including enjoyment of food, emotional overeating, emotional undereating, food fussiness, responsiveness, slowness in eating, hunger and satiety response. The Emotional Appetite Questionnaire (EMAQ),[30] measures emotional responses to eating in positive and negative situations. Participants are given different emotions and situations to associate with and decide whether they eat much more or much less on a scale of 1-9 in these situations. The higher the negative score, the higher the BMI a person is likely to have and the higher the positive score, the lower the BMI. These measures were used to to help explain weight change by determining any changes in eating behaviour at different time points throughout the smoking cessation attempt.

Physical activity

Changes in physical activity levels over the different time points can help to explain changes in weight. The Global Physical Activity Questionnaire (GPAQ),[31] was used to understand physical activity at different time points of the smoking cessation attempt. This questionnaire measures physical activity levels including travelling, work, recreational activities and amount of time spent sedentary. The average number of active minutes is found to be around 30minutes per week for women and 43 minutes per week for men and the average number of sedentary minutes per week is 240 for women and 360 for men.

Nicotine dependence

The Fagerstrom test for Nicotine Dependence [32] is scored by adding responses to give a final score of nicotine dependence out of 10 with a mean average score of 6. A score of 1-2 indicates low dependence, 3-4 moderate dependence, 5-7 moderate dependence and 8+ high dependence.

Procedure

The University Psychology Research Ethics Committee approved the study.

Baseline session

Participants were routinely attending a local borough stop smoking service for smoking cessation support. Within their first session, participants were given an information sheet and invited to take part in the study. Upon signed consent, participants were weighed, had their waist circumference measured and smoking cessation aid noted. Participants were then asked to complete the set of questionnaires in randomised order.

Week 4, Week 12 and 6 months follow up

During follow-up appointments, participants completed the set of questionnaires in randomised order, had their weight, waist circumference and height measured and smoking status recorded. At the final 6-month time-point, participants were fully debriefed and asked for their feedback on the study.

Data analyses

Firstly, to explore the effects of smoking cessation aid on weight, a mixed ANOVA, followed by repeated measures t-tests, was used to examine differences in weight between smoking cessation aids. Correlations were conducted to examine the relationships between weight and other variables across different time points. Multiple regressions was used to identify predictors of weight change in smoking cessation. Where appropriate, non-parametric and post-hoc testing took place. A repeated measure mixed ANOVA was used to explore ethnicity and weight change during smoking cessation.

Results

Weight change across different time points

There was a significant change in weight between baseline and 12 weeks (t=.817, df=65, p=.001, S.D=2.33, d=0.07), baseline and 6 months (t=4.86, df=65, p<.0001, S.D=2.82, d=0.11), week 4 and 6 months (t=2.35, df=65, p=.022, S.D=8.87, d=0.19) and week 12 and 6 months (t=5.71, df=65, p<.0001, S.D=.99, d=0.04). There were significant changes in BMI at different time points: baseline and 12 weeks (t=3.56, df=65, p=.001, S.D=.880, d=0.07), baseline and 6 months (t=4.45, df=65, p<.0001, S.D=1.20, d=0.12), week 4 and week 12 (t=2.55, df=65, p=.013, S.D=1.41, d=0.05) and week 12 and 6 months (t=3.81, df=65, p<.0001, S.D=.580, d=0.05). There were also significant changes in waist circumference at different time points: baseline and 6 months (t=2.77, df=65, p=.007, S.D=1.80, d=0.10), week 4 and 6 months (t= 2.56, df=65, p=.013, S.D=2.09, d=0.11) and week 12 and 6 months (t=3.32, df=65, p=.001, S.D=.719, d=0.049).

Relationships between cessation aid and weight change

As can be seen in Table 1, the most weight gain (3kg) was found among the NRT group, followed by Champix (2kg) and e-cigarettes (1kg). The largest change found in BMI and waist circumference was again found among the NRT group. However, by comparing

Citation: Whippy N, Lusher JM. The influence of cessation aid on predicting weight change during smoking cessation. *MOJ Addict Med Ther.* 2019;6(1):55–60. DOI: 10.15406/mojamt.2019.06.00147

the effect of smoking aid on weight change, a repeated measures, between-subjects ANOVA revealed no significant change for weight F(2,63)=.406, p=.668, BMI F(2,63)=.486, p=.618 or waist circumference F(2,63)=.550, p=.580.

To help with interpretation of these findings, other variables that are relevant to weight were examined for each smoking cessation aid group. As can be seen in Table 1, the NRT category were the eldest, least active and most sedentary. This group also had the lowest alcohol consumption but had the highest FTND score (6). Of the Champix group, 92% had prior quit attempts using NRT. They were the most active group with the least sedentary behaviour and the highest alcohol consumption. The e-cigarette category had the highest percentage of men (68%), they had a higher mean weight at baseline and were generally more sedentary with lower alcohol use. NRT was significantly positively correlated with previous smoking cessation weight gain (r=.313, n=66, p=.011), previous cessation exercise, (r=.314, n=66, p=.010) and slowness in eating at baseline (r=.260, n=66, p=.035), week 4, (r=.316, n=66, p=.010) and week 12 (r=.309, n=66, p=.012). Champix was significantly negatively correlated with previous cessation weight gain (r=-.347, n=66, p=.004) and previous eating habits (r=-.272, n=66, p=.027). There was a significant positive correlation between Champix and hunger at all time points (week 4: r=.246, n=66, p=.046; week 12: r=.250, n=66, p=.043 and 6 months: r=.254, n=66, p=.039). A significant negative correlation emerged between Champix and Satiety Response at week 4 (r=-.267, n=66, p=.030), week 12 (r=-.251, n=66, p=.042) and 6 months (r=-.251, n=66, p=.042). Finally, e-cigarettes were found to have a significant positive correlation with Recreational Active minutes at baseline (r=.255, n=66, p=.039), week 4 (r=.310, n=66, p=.016) and week 12 (r=.296, n=66, p=.016). P values were adjusted for multiple testing.

Table 1 Participant characteristics

Variable		Whole group N (%)/M(SD)	NRT	Champix	E-cigarette	Asian	Non-Asian
Number of Participants		66 (100)	21 (32)	23 (35)	22 (33)	28 (42)	38 (58)
Sex	Men	39 (59)	12 (57)	12 (52)	15 (68)	23 (82)	17 (44)
	Women	27 (41)	9 (43)	11 (48)	7 (32)	5 (18)	21 (66)
Ethnicity	Asian	28 (43)	11 (52)	6 (26)	11 (50)		
	Non-Asian	38 (57)	10 (48)	17 (74)	11 (50)		
Previous smoking cessation	Yes	45 (68)	10 (48)	21 (91)	14 (63)	17 (61)	29 (76)
	No	21 (32)	11 (52)	2 (9)	8 (37)	11 (39)	9 (24)
Last quit attempt	Last Month	1 (2)	0	3 (13)	2 (10)	1 (4)	3 (8)
	Last Year	36 (55)	9 (43)	15 (65)	12 (53)	16 (57)	21 (56)
	Over 1 year	8 (12)	0	0	0	0	6 (16)
	Few years ago	0	0	3 (13)	0	0	0
	Over 5 years	0	1 (5)	0	0	0	0
	N/A	21 (32)	11 (52)	2 (9)	8 (37)	11 (39)	8 (20)
Previous cessation aid	NRT	22 (33)	7 (33)	8 (35)	8 (37)	11 (39)	13 (33)
	Champix	8 (12)	0 (0)	4 (17)	0	0	7 (17)
	None	15 (23)	3 (15)	7 (30)	6 (26)	6 (22)	10 (26)
	N/A	21 (32)	11 (52)	6 (26)	8 (37)	11 (39)	9 (24)
Previous weight gain	Yes	2 (3)	0	1 (4)	1 (5)	1 (4)	1 (2)
	No	43 (65)	10 (48)	20 (87)	13 (58)	16 (57)	28 (74)
	N/A	21 (32)	11 (52)	2 (9)	8 (37)	11 (39)	9 (24)
Exercise	Yes	6 (9)	1 (5)	1 (4)	4 (18)	2 (7)	4 (11)
	No	60 (91)	20 (95)	22 (96)	18 (82)	26 (93)	34 (89)
Previous exercise	Yes	7 (10)	1 (5)	2 (9)	4 (18)	2 (7)	4 (11)
	No	38 (58)	9 (43)	19 (83)	10 (45)	15 (54)	25 (65)
	N/A	21 (32)	11 (52)	2 (9)	8 (37)	11 (39)	9 (24)
Alcohol units	0 units	38 (58)	13 (62)	11 (48)	14 (64)	27 (96)	11 (28)
	1-4 units	14 (21)	8 (38)	4 (17)	8 (36)	1 (4)	18 (47)
	5-10 units	11 (17)	0	8 (35)	0	0	10 (25)
	10+ units	3 (4)	0	0	0	0	0

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Table Continued...

Variable		Whole group N (%)/M(SD)	NRT	Champix	E-cigarette	Asian	Non-Asian
Previous alcohol units	0 units	38 (58)	13 (62)	11 (48)	14 (64)	27 (96)	11 (28)
	1-4 units	14 (21)	8 (38)	4 (17)	8 (36)	1 (4)	18 (47)
	5-10 units	11 (17)	0	8 (35)	0	0	10 (25)
	10+ units	3 (4)	0	0	0	0	0
Smoking aid	NRT	21 (32)				11 (39)	10 (27)
	Champix	23 (35)				6 (22)	17 (45)
	E-cigarette	22 (33)				11 (39)	11 (28)
Age (years)		46(14.88)	53(15.13)	43(4.22)	43(3.63)	47(14.29)	46(15.45)
Height (metres)		1.7(.075)	1.68(.078)	1.7(.067)	1.7(.080)	1.7(.074)	1.7(.076)
FTND score		5 (2.21)	6(2.29)	5(2.14)	5(2.27)	5(2.19)	5(2.21)
Baseline weight (kg)		75(15.96)	71(13.28)	75(16.41)	77(17.88)	78(16.02)	72(15.72)
Week 4 weight (kg)		74(17.58)	72(12.97)	75(16.32)	77(22.63)	78(15.41)	71(18.65)
Week 12 weight (kg)		76(15.40)	73(13.36)	76(16.44)	77(16.43)	78(14.88)	73(15.64)
6-month weight (kg)		76(15.55)	74(13.33)	77(17.03)	78(16.32)	79(14.67)	74(16.07)
Baseline BMI		26(5.33)	25(3.84)	26(5.35)	27(6.44)	28(4.85)	25(5.42)
Week 4 BMI		26(5.28)	26(3.74)	26(5.60)	27(6.22)	28(4.60)	25(5.55)
Week 12 BMI		27(5.23)	26(3.99)	26(5.61)	27(5.97)	28(4.52)	26(5.51)
6 month BMI		27(5.28)	26(3.92)	27(5.85)	27(5.92)	28(4.43)	26(5.66)
Baseline waist circumference (inches)		35(6.43)	35(5.79)	35(6.41)	37(7.09)	37(6.06)	34(6.39)
Week 4 waist circumference (inches)		35(6.39)	35(5.66)	34(6.65)	37(6.82)	37(5.95)	34(6.36)
Week 12 waist circumference (inches)		36(5.97)	35(5.78)	35(6.35)	37(5.93)	37(5.21)	35(6.23)
6-month waist circumference (inches)		36(6.11)	36(5.89)	35(6.52)	37(6.07)	37(5.31)	35(6.38)
Baseline active minutes		96(527.33)	64(44.2.60)	131(658.65)	90(443.33)	53(383.96)	107(599.83)
Week 4 active minutes		89(507.78)	57(443.53)	127(662.98)	78(355.86)	42(294.99)	120(603.37)
Week 12 active minutes		77(506.71)	58(442.89)	128(661.32)	78(354.69)	34(294.55)	119(601.64)
6-month Active Minutes		89(512.18)	58(442.95)	130(673.22)	78(353.74)	42(291.94)	121(609.23)
Baseline Sedentary Minutes		310(154.17)	331(161.69)	271(115.65)	330(179.28)	326(146.45)	300(160.57)
Week 4 Sedentary Minutes		305(150.80)	305(157.12)	274(115.65)	315(175.11)	319(137.65)	294(160.90)
Week 12 Sedentary Minutes		298(150.17)	335(154.26)	269(115.65)	315(175.11)	319(137.65)	292(159.79)
6 month Sedentary Minutes		309(149.75)	340(152.36)	274(115.59)	315(175.11)	319(137.65)	302(159.43)

Sex and weight change during smoking cessation

Multiple stepwise regression revealed that above and beyond all other related variables, sex was the only significant predictor of weight change during cessation attempt $F(1,64) = 4.37$, $p=.041$, adjusted $R^2 = .049$). Mean weight change in women was 2.94kg, waist difference was 1.11 inches and BMI difference was 1.56, compared with men (mean weight change of 1.68kg; waist difference 0.72 inches and BMI difference of 0.79). Multiple Regression analysis using the standard enter method was used to examine predictors of BMI change in women and a significant model emerged ($F(11,15)=2.56$, $p=.047$). The main significant predictors of BMI in women were e-cigarette use and eating behaviours, which explained 65% of the variance in BMI change in women only (adjusted $R^2=.397$). Similarly, multiple regression performed for waist difference in women revealed a significant model ($F(11,15)=3.33$, $p=.016$) with e-cigarettes and eating behaviours as the main predictors of waist circumference change during smoking cessation, explaining 71% of the variance (Adjusted $R^2=.497$). No significant model emerged when the same analyses were performed with men.

Relationships between weight change and ethnicity

As shown in Table 1, when comparing sex with weight, BMI and waist circumference changes, the largest change can be seen among the Non-Asian category (2kg) compared with the Asian category

(1kg increase). By comparing the effect of ethnicity on weight, BMI and waist circumference using repeated measures, between-subjects ANOVA, there was no significant change in weight found, $F(1,64) = 2.04$, $p=.158$, but there was a significant change in BMI $F(1,64) = 4.05$, $p=.048$ and waist circumference $F(1,64) =4.88$, $p=.031$.

Discussion

In the present study, the influence of cessation aid on weight change during smoking cessation appears negligible as sex was found to be the main predictor of weight change and eating behaviour was the main predictor of change in BMI and waist circumference; with cessation aid redundant in this case. Women are more likely than men to diet and be concerned about their weight and eat healthily. However, dieting and restricting food has also been shown to increase binge eating and therefore lead to weight gain.[33] There are several models that could explain behaviour and behaviour change leading to weight gain during smoking cessation. However, the theory of planned behaviour [34] could be applied particularly to understand why women are more likely to gain weight when giving up smoking in that a lack of perceived behavioural control over diet during smoking cessation can lead to weight gain. When examining potential contributors to changes in BMI in men and women separately, exercise and alcohol use were not implicated. Women gained almost double the weight in the e-cigarette group compared to men and so the predictor of changes in BMI is not a reduction but an increase in weight and BMI.

Women are more likely than men to diet, be emotional eaters and be concerned about their weight and eat healthily.[35] However, dieting and restricting food has also been shown to increase binge eating and therefore lead to weight gain.[33] Women have also been found more likely to eat as a response to stress and reach for sugar-rich foods during this time.[36] However, in the present study, the shortage of women in the e-cigarette group makes conclusions difficult to draw and a more representative sample of women may have produced changes in overall weight.[37–40]

One of the aims of this study was to determine whether the use of e-cigarettes results in less weight gain when used as a smoking cessation aid over other methods (NRT, Champix). Although a significant change in weight, BMI and waist circumference from baseline to 6 months was found, this occurred regardless of choice of cessation aid. The results from the present study and previous research do concur that weight change does happen during smoking cessation, however, it is apparent here that it is important to further elucidate what factors might influence this. Overall, the smoking cessation aid associated with the largest change in weight, BMI and waist circumference was NRT, with the e-cigarette showing the least change. This finding does suggest that smoking cessation aid might play a small part, however, other factors such as activity levels might have impeded, whereby one lifestyle change led to another health behaviour change.[28]

This study focused on weight gain in smoking cessation, particularly among the Asian population; due to their higher risk for developing cardiovascular disease.[19] The greatest weight gain over the six month timeframe was found across the non-Asian group. Previous research has shown continued smoking to be a factor in Asian communities to prevent weigh gain.[21–23] However, in line with other findings, there were more men than women in the Asian category and this could help to explain why the non-Asian group gained more weight overall in this particular instance.[41–44]

Future work might consider weight change beyond the six month cessation period and whether participants lose the gained weight, continue to gain, or stabilise their weight overtime. It was considered that six months would be an appropriate timeframe in which to reflect weight change. It is also likely that any change in weight after the 6-month time-point would not be a direct result of quitting smoking. The biggest problem with the present study, which interferes with interpretation of the findings, is that it wasn't a randomised controlled intervention and participants self-selected what cessation aid they joined prior to commencement of the study. Further research might want to consider addressing such shortfalls. However, this present study was the first of its kind to examine the impact of using e-cigarettes as a smoking cessation aid and the affect this might have on weight change during a cessation attempt. Future studies should appreciate the rapid rate in which products are evolving and the potential impact this could have on future findings. Ultimately, our position is that we acknowledge e-cigarettes as having potential to assist smokers in reducing or quitting conventional cigarettes, however, cessation aid is not the best way for women to reduce cessation-related weight gain. Behavioural change services that target healthy eating and lifestyle behaviours during smoking cessation to help women to prevent weight gain during this process would prove fruitful.[45,46]

Acknowledgments

We are grateful to all participants who agreed to take part in this study

Conflicts of interest

Author declares that there are no conflicts of interest.

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